CLAIMS

Claim 1. A process for removing contaminants, said contaminants including dissolved chlorinated hydrocarbons and dissolved hydrocarbon products in the form of subsurface plumes, including leachate plumes which contain dissolved chlorinated hydrocarbons, said process comprising the steps of:

a) evaluating a site for the purpose of identifying contaminants present and matching of microfine sparge system components to soil characteristics of said site for effective treatment of said contaminants;

b) installing a vertical injection well system matched to the site for optimum treatment;

c) installing a microfine sparge system having in-well microfine sparge apparatus including microporous bubble generators and well head control apparatus at each injection well of said well system;

d) selection of appropriate bubble size distribution for optimizing gaseous exchange in the aquifer by matching microfine sparge apparatus components including microporous materials used in bubble generators, surrounding sand pack, sizing bubble chamber and programming wave form of pulsed gas/water injection with reference to evaluation results;

e) construction of an in-well bubble chamber in each injection well with recirculation system controlling the size of bubbles by means of a vertically arranged bubble chamber for distribution of microfine bubbles through substrate material under Darcian flow approximating fluid flow exhibiting mounding and outward movement;

f) controlling the supply of gas for even bubble dispersion through soil and improved rate of gaseous exchange;

g) alternating water injection with bubble production to provide a continuous flow of micron sized bubbles ;

h) injecting and distributing microbubbles into said aquifer containing sand to be treated by means of pressure applied to gas injection, matching size of components to pore configuration, recirculating wherein a wave form is produced effective to assist flow distribution in said aquifer;

i)selectively pulling volatile organic compounds (VOCs) into the small bubbles for decomposition in a gas/gas/water reaction; and.

j) providing even distribution of microbubbles into aquifer containing sand wherein the substrate material acts as co-reactant with the gas for decomposing the VOCs in the gas/gas/water reaction.

Claim 2. The process of claim 1 wherein the microfine bubbles of oxidizing gas include oxygen and ozone.

Claim 3. The process of claim 1 wherein the microporous diffusors are matched to soil conditions on the site, fluid acceptance range and critical operating range to avoid fracturing of the substrate structure .

Claim 4. The process of claim 2 wherein the microfine bubbles of oxidizing gas extract volatile dissolved PCE, TCE, and DCE, VOCs while encapsulated ozone decomposes them by providing

even distribution of microbubbles into an aquifer containing sand wherein the substrate material act as co-reactant with the gas for decomposing the VOCs in a gas/gas/water reaction.

Claim 5. The process of claim 2 wherein the microfine bubbles of oxidizing gas employ a gas mixture (air/ozone) to fill microbubbles to allow a rapid decomposition of certain volatile organic carbon compounds (VOCs) extracted from the groundwater wherein said system provides for varying the respective concentrations of oxygen and ozone respectively.

Claim 6. The process of claim 1 further comprising the steps of simultaneously extracting and decomposing certain organic compounds with high Henry's Constants by matching time of exposure for decomposition to vertical travel time of microfine bubbles thereby avoiding the need for vapor recovery since VOCs are decomposed before reaching a unsaturated soil zone.

Claim 7. The process of claim 1 further employing specially-designed wellheads to equalize injected flow between formations of differing permeability.

Claim 8. The process of claim 1 further employing zone control bubble zone overlap and periodically pulsing to improve dispersion area of influence and avoid movement of floating product.

Claim 9. The process of claim 1 further employing sensing with pressure monitoring and groundwater sensing to remotely monitor and regulate the mixing/reactions of said process.

Claim 10. The process of claim 1 further employing the use of alternating pumpage and bubble injection to maximize dispersal of bubbles within and outward from casing of said injection well casing.

Claim 11. The process of claim 1 further employing use of a physical arrangement of sequentially arranged microporous diffusors to form a slanted angle while maintaining independent pressure and flow control.

Claim 12. A sparging system for in-situ removal of contaminants from soil and an associated subsurface groundwater aquifer of a site with microbubbles in combination with substrate material having a defined porosity comprising

a) means for evaluating the site for the purpose of matching of system components to soil characteristics for effective fluid transition there through;

b) microbubble means capable of extracting contaminant in the form of gas from groundwater in a gas/gas/water reaction comprising at least one microporous diffusor having a porosity matched to the defined soil porosity;

c) injection well means for injecting said microbubbles in said site;.

d) means for encapsulating ozone in said microfine bubbles to enhance extraction of volatile dissolved contaminants for in-situ decomposition.

e) injecting means for filling microbubbles with a variable mixture of gas containing oxygen and ozone to allow a rapid decomposition of volatile organic carbon compounds (VOCs) extracted from groundwater;

f) means for controlled selection of size of microbubbles to promote rapid extraction of selected volatile organic compounds wherein the small size of the bubbles and defined rise time is

matched to short life time of an oxidative gas to allow rapid dispersion into water saturated formations in bubble chamber means.

g) means for forming a wave form for assisting flow of bubbles;

h) co-reactant means wherein the substrate material act as co-reactant with the gas for decomposing the VOCs in a gas/gas/water reaction;.

i) recirculating means for regulating bubble size;

j) lateral dispersions means for alternating pumpage and bubble injection to maximize dispersal of bubbles within and outward from injection well casing, and to provide uniform dispersion of the bubbles as they travel through the site formation

k) bubble chamber means and

l) packing means having a porous structure matching the condition of porosity of the soil with 30 percent (30%) pore distribution and

m) remote control means for sensing with pressure monitoring and groundwater sensing to remotely monitor and regulate mixing operation of the system.